FINAL REPORT

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Laser Physics Branch
Optical Sciences Division
Naval Research Laboratory
Washington, D.C. 20390

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The research reported here has been carried out in-house at the Naval Research Laboratory and under a small contract ($25K) to Cornell University. These two programs will be discussed separately although the Cornell work is supportive of a primary goal of the NRL program. The NRL work is jointly sponsored by ONR, ARPA, and by in-house NRL funds.

NRL PROGRAM

The DF-CO_2 vibrational transfer chemical laser has been operated successfully. A power output of 15 watts in a pure spatial mode was obtained with the laser operated as a single pass oscillator. The good beam quality evidenced in the laser's mode structure is an optimistic sign that a powerful beam of high optical quality can be obtained from the DF-CO_2 system. Due to improper injection and mixing of some reactants, only a fraction of the available path length perpendicular to the gas flow supported oscillation. The low gain of the short lasing region prevented the extraction of the available laser power and resulted in an output of 15 watts. A new metallic flow reactor is nearing completion. This new chamber will correct the gas injection problems of the previous design and the output power performance is expected to be greatly enhanced. This new design will also incorporate features which will be used in a parametric study of the DF-CO_2 system to be carried out in FY 71.

The CS_2-O, CO chemical laser has been constructed and is now operating in the small longitudinal flow facility. Two important aspects concerning the operation of fluid mixing chemical lasers has been born out, i.e., the importance of efficient mixing of reactants and the efficacy of altering the intrinsic vibrational population distribution produced in a chemical reaction by the addition of collision partners to form a distribution which

is more favorable for a laser. The importance of good mixing is demonstrated by a factor of 3 increase in output power from the introduction of turbulence into the gas mixing process. Another factor of 3 increase in the output power was obtained by adding unexcited N_2O to the CS_2. The N_2O is probably serving as an efficient de-activating collision partner for CO.

The high pressure, transverse discharge excitation laser system has been used to study the efficiency of different electrode configurations for this type of laser. The laser is presently operating at a power level of 1 megawatt in a 500 nsec long pulse. Chemical HF lasers have been produced using this method of excitation in a variety of fluorinated hydrocarbon compounds.

CORNELL PROGRAM

The experiment at Cornell with the primary objective of measuring the rate of deactivation of CO_2 (001) by collisions with DF and HF is nearing completion. The method employed is to place a heated cell containing DF + CO_2 inside a Q switched CO_2 laser and to monitor the 4.3μ infrared emission from CO_2 (001) as a function of time after irradiation with a short laser pulse. The data is taken as a function of DF pressure and relaxation by CO_2-CO_2 collisions is taken into account by use of prior data obtained by Bradley-Moore. A secondary objective will be to measure the pumping rate of DF by CO_2 (001) by measuring infrared radiation from DF. This pumping rate is related to the inverse process by which CO_2 is pumped by DF in the flow laser under construction at NRL. Both these rates are unknown and are important for design and analysis of the CO_2 pure chemical laser under study at NRL. Preliminary data for the deactivation of HF by CO_2 gives a rate constant of 2000 sec^{-1} $torr^{-1}$.

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13. ABSTRACT

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The [illegible], CO chemical laser has been constructed and is now operating in the small longitudinal flow facility. Two important aspects concerning the operation of fluid mixing chemical lasers has been born out, i.e., the importance of efficient mixing of reactants and the efficacy of altering the intrinsic vibrational population distribution produced in a chemical reaction by the addition of collision partners to form a distribution which is more favorable for a laser.

The high pressure, transverse discharge excitation laser system has been used to study the efficiency of different electrode configurations for this type of laser. The laser is operating at a power level of 1 megawatt in a 500 nsec long pulse. [illegible] of lasers have been produced using this method of excitation in a variety of fluorinated hydrocarbon compounds.

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